

APPENDIX "C"

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UNIT OPERATIONS OF CHEMICAL ENGINEERING

Fourth Edition

Warren L. McCabe

*Late R. J. Reynolds Professor in Chemical Engineering
North Carolina State University*

Julian C. Smith

*Professor of Chemical Engineering
Cornell University*

Peter Harriott

*Fred H. Rhodes Professor of Chemical Engineering
Cornell University*

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A second example of simple heat-transfer equipment is the double-pipe exchanger shown in Fig. 11-3. It is assembled of standard metal pipe and standardized return bends and return heads, the latter equipped with stuffing boxes. One fluid flows through the inside pipe and the second fluid through the annular space between the outside and the inside pipe. The function of a heat exchanger is to increase the temperature of a cooler fluid and decrease that of a hotter fluid. In a typical exchanger, the inner pipe may be $1\frac{1}{2}$ in. and the outer pipe $2\frac{1}{2}$ in., both IPS. Such an exchanger may consist of several passes arranged in a vertical stack. Double-pipe exchangers are useful when not more than 100 to 150 ft² of surface is required. For larger capacities, more elaborate shell-and-tube exchangers, containing up to thousands of square feet of area, and described on pages 383 to 386, are used.

Countercurrent and parallel-current flows The two fluids enter at different ends of the exchanger shown in Fig. 11-3 and pass in opposite directions through the unit. This type of flow is that commonly used and is called *counterflow* or *countercurrent flow*. The temperature-length curves for this case are shown in Fig. 11-4a. The four terminal temperatures are denoted as follows:

Temperature of entering hot fluid, T_{ha}

Temperature of leaving hot fluid, T_{hb}

Temperature of entering cold fluid, T_{ca}

Temperature of leaving cold fluid, T_{cb}

The approaches are

$$T_{ha} - T_{cb} = \Delta T_2 \quad \text{and} \quad T_{hb} - T_{ca} = \Delta T_1 \quad (11-1)$$

The warm-fluid and cold-fluid ranges are $T_{ha} - T_{hb}$ and $T_{cb} - T_{ca}$, respectively.

If the two fluids enter at the same end of the exchanger and flow in the same direction to the other end, the flow is called *parallel*. The temperature-length curves

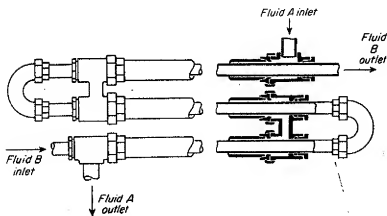


Figure 11-3 Double-pipe heat exchanger.

Hawley's

Condensed Chemical

Dictionary

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Richard J. Lewis, Sr.

Marshall, O'Toole, Gerstein, Murray & Bonin
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couch roll. (Pronounced cooch.) A hollow suction roll on a fourdrinier paper machine over which the formed sheet or web passes as it leaves the wire. The suction is provided by a vacuum or suction box inside the roll, whose face is perforated to offer as large a vacuum area as possible. The chief feature of the couch roll is its great water-removing capacity; this gives the sheet enough strength to enable it to hold together as it passes to the pickup felts.

coumaphos. Generic name for *O,O*-diethyl-*O*-(3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl)-phosphorothioate.
CAS: 56-72-4. $C_{10}H_{10}O_4(CH_3)_2ClOPS(OC_2H_5)_2$.
Properties: Crystals. Mp 91°C. Insoluble in water; soluble in aromatic solvents.
Hazard: Use may be restricted; cholinesterase inhibitor.
Use: Insecticide, anthelmintic.

coumarin. (coumarin; benzopyrone; tonka bean camphor).
CAS: 91-64-5. $C_9H_6O_2$. A lactone.
Properties: Colorless crystals, flakes, or powder; fragrant odor similar to vanilla; bitter, aromatic burning taste. Mp 69°C, bp 290°C. Soluble in 10 vols of 95% alcohol and in ether, chloroform, and fixed volatile oils; slightly soluble in water. Combustible.
Derivation: (1) By heating salicylic aldehyde, sodium lactate, and acetic anhydride; (2) fine grades are isolated from tonka beans.
Hazard: Toxic by ingestion; carcinogenic. Use in food products prohibited (FDA).
Use: Deodorizing and odor-enhancing agent, pharmaceutical preparations.

coumarone. (benzofuran).
CAS: 271-89-6. C_9H_6O . A bicyclic ring compound derived from coal tar naphtha, the parent substance of coumarone-indene resins.
Properties: Colorless, oily liquid. D 1.09, bp 165 to 175°C. Insoluble in water.

coumarone-indene resin. A thermosetting resin derived by heating a mixture of coumarone and indene with sulfuric acid, which induces polymerization. It is soft and sticky at room temperature; it hardens on heating to a resinous solid. Soluble in hydrocarbon solvents, pyridine, acetone, carbon disulfide, and carbon tetrachloride; insoluble in water, alcohol. Combustible. Said to have been the first synthetic polymer.
Use: Adhesives, printing inks, floor-tile binder, friction tape.
See "Cumar"; "Nevindene"; "Paradene."

count. (1) The external indication given by a radiation detector, such as a Geiger counter, of the

amount of radioactivity to which the detector is exposed. The background counts are those that come from a source external to that being measured. (2) The number of warp and filler threads in a linear inch of a textile fabric, e.g., the count of a sheeting may be 80 x 60.

countercurrent. Descriptive of a process in which a liquid and a vapor stream, or two streams of immiscible liquids, or a liquid and a solid are caused to flow in opposite directions and past or through one another with more or less intimate contact so that the individual substances present are more or less completely transferred to that stream in which they are more soluble or stable under the conditions existing. The streams leaving such a process are usually of higher purity than can be attained otherwise at equal cost. Distillation with a fractionating column is also a typical countercurrent process, in which rising vapor is purified by contact with descending liquid (reflux). Leaching, washing, and chemical reaction are frequently carried out in a countercurrent manner.
See liquid-liquid extraction.

coupling. (1) The combination of an amine or phenol with a diazonium compound to give an azo compound, the reaction by which azo dyes are prepared. Thus *m*-phenylenediamine $C_6H_4(NH_2)_2$ couples with benzene diazonium chloride $C_6H_5N_2Cl$ to produce the dye chrysoidine $C_6H_4N_2C_6H_5$.
(2) Oxidative coupling.
(3) An agent, e.g., a vinyl silane, used to protect fibrous glass laminates from effects of water absorption. (4) A condensation polymerization of amino acids to form proteins; it can be done synthetically only by suppressing certain active sites on the amino acid molecules.

covalent bond. (homopolar). Sharing of electrons by a pair of atoms.
See bond, chemical.

covering power. See opacity.

Cowles process. The direct manufacture of aluminum alloys, such as copper aluminum, from aluminum ores by reacting with carbon in an electric furnace in the presence of the alloying metal.

Cox chart. A special semilogarithmic plot of vapor pressure versus temperature especially useful for the petroleum hydrocarbons. The graph corresponding to each separate hydrocarbon is a straight line. All the lines appear to intersect at a point outside the chart.

CP. Abbreviation for chemically pure, an accepted grade of drugs and fine chemicals that contain a minimum of impurities.
See chemically pure.